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ABSTRACT

A study was conducted to examine the relationship of reading rate to comprehension on material read with a pacer and without a pacer. Two hundred paired scores were obtained in a college reading and study skills course in which students read both paced and nonpaced material alternately during class time and recorded their rate and comprehension scores for each reading. The results showed that the relationship between reading rate and comprehension was not constant in nonpaced materials. Below approximately 250 words per minute, there was positive and significant correlation between rate and comprehension, yet above that rate little or no relationship was found. No significant correlation was found between rate and comprehension on paced material. (FL)

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READING RATE AS A FACTOR IN COMPREHENSION AT THE COLLEGE LEVEL

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Many college reading programs attempt to teach students to read rapidly. This rapid reading is intended to aid students in reading the volume of material required in college coursework. Such programs generally include comprehension checks after paced and non-paced reading. Of interest to the investigators was the relationship of rate to comprehension on college-level reading material, both after paced and non-paced reading.

This study is twofold in that it 1) examines the relationship of rate to comprehension on material read with a pacer, and 2) examines the same relationship on material read without the use of a pacer. Two hundred two paired scores were obtained during winter and spring quarters of 1980 in Reading 1000, a reading and study skills course at East Tennessee State University. The instructor was the same for all students and classroom procedure was the same for all classes. Students read both paced and non-paced material alternately during class time and recorded rate and comprehension scores for each reading. Pacers used were SRA models.

Review of Related Literature

Authors of several reading textbooks have suggested that there is a close relationship between rate and comprehension (Bond and Tinker, 1967 Guszak, 1972; and Harris, 1968.) Harris (1968) stated that one would expect

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to find a high relationship between rate and comprehension and he cited research which supported his belief. This study is specifically interested in the relationship on paced and non-paced reading by students at the college level. In order to survey pertinent research, however, studies were reviewed which dealt with several age levels. This was done in an effort to see if correlational findings changed according to age and nature of material read. No correlational rate and comprehension research was found which dealt with paced versus non-paced reading per se. Studies were reviewed which investigated imposed time limits for reading, and their results are of interest by comparison.

Relating Speed and Comprehension. Blommers and Lindquist (1944) after surveying studies comparing reading rate and comprehension reported correlation coefficients between them ranging from -0.47 to +0.92. These correlational findings are not surprising, in that subjects were tested at many grade levels. Blommers and Lindquist investigated the relationship between rate and comprehension on tests developed to yield measures valid for such a study. They cited the following items as affecting reading rate: the nature of the material used--vocabulary load, sentence structure, difficulty, typographical features; the reader himself--his skills, habits, mental and physical state, etc. They reported the following observations:

1. The relationship between rate of reading and reading comprehension is significant but low (+0.30).

2. An individual tends to maintain approximately the same rank in rate of successful reading in a given group despite differences such as usually found in the difficulty and nature of individual selections used in reading comprehension tests.

3. Good comprehenders adjust their rate of reading by slowing somewhat as the material increases in difficulty, whereas poor comprehenders apparently read easy and difficult materials at much the same rate.

In an earlier study Judd (1916) concluded that high rate and good quality of reading are commonly related and low rate and poor quality are commonly related. Based on five reading tests, Gates (1921) found a correlation of +0.84 between composite reading rate score and composite comprehension score. He contended that in detailed individual analyses of cases there is a real and useful distinction between the terms "ability to comprehend" and "rate of reading." King (1916), however, in contrast to the other findings, obtained a correlation of -0.47 between the two. This disagreement seems to be a function of testing procedures, materials chosen, and reader characteristics. Many of the positive correlations between rate and comprehension resulted from the time element in testing. In those cases, rate became a function of comprehension as a result of the readers working against time. Timed tests seemed to favor fast readers because the slow readers were not able to finish answering questions.

Preston and Botel (1951) tested the hypothesis that speed and comprehension are unrelated. They found a statistically significant correlation (+0.48) between rate and timed comprehension and a nonsignificant relationship (+0.20) between rate and untimed comprehension. They concluded that tests of reading which include speed in the measurement of comprehension are invalid measures because speed and comprehension are relatively independent of each other. In studying the relationship between speed and comprehension when no time limits were introduced, Stroud and Henderson (1943) found the correlation of time and comprehension low and concluded the factors were independent. They hypothesized that imposing time limits on reading tests produces positive and significant correlations between the two variables.

Shores and Husbands (1950) examined the hypothesis that faster readers were better readers on problem-solving material when a purpose was set for reading. They concluded that there is almost no relationship between speed and comprehension when (1) speed and comprehension are measured simultaneously using science material; (2) the purpose for reading is given in advance; (3) inferences

are required before problem solving; and (4) critical thinking is required for comprehension. They contended that comprehension is less dependent on speed than on intelligence. Shores (1961) replicated their work and found that speed was influenced by purpose. Adults were found to be more flexible than children in altering reading style according to purpose.

The manner in which comprehension is measured also affects the correlation between rate and comprehension. Letson (1958) found relatively high correlations (+0.46 and +0.77) between rate and correct number of items (on a comprehension measure) and a correlation of -0.10 between comprehension and the number of items attempted. He concluded that the relationship between speed and comprehension decreases as the difficulty of the material increases.

Robinson and McCollum (1934) studied the upper 15 percent and the lower 15 percent of a group of students to determine the relative influence of rate and comprehension on reading test scores. They concluded that good readers score higher in both speed and comprehension but speed is the greater determinant of test scores. Comprehension questions covering higher levels of questioning favor good readers. In all of the studies mentioned in this paper there is no consistent control for the potential effects of a confounding of rate and comprehension variables. These may have influenced the divergent correlations reported. This may account, in part, for the "fast readers are good readers" findings cited.

The measurement of speed and comprehension is a controversial issue. According to Davis (1962),

> Number of words read per minute is, in itself, a meaningless score. To be meaningful, it must be associated with a score indicating the extent of comprehension that has been attained (p. 30).

Spache (1962) challenged the idea of multiplying the two scores for rate and comprehension as a measure of effective rate. Braam (1963), however, advocated such a practice.

There is evidence to support the hypothesis that a relationship between

comprehension and rate may depend upon the nature of the test materials themselves. Tinker (1932) cited three research methods which were used to obtain rate and comprehension correlations. The first method compared the speed with which a text is read with the recall of the material. This comparison usually yielded low correlations. Tinker (1932) asserted that recall of this type is not comprehension; therefore, the correlations obtained were invalid. The second technique involved obtaining speed and comprehension scores from children who were reading different materials. Tinker (1932) criticized this approach because the subject matter differed from test to test and the correlations obtained measured "somewhat different combinations of the many functions involved in reading" (p. 159).

The third method compared rate and comprehension on identical reading texts. These correlations were consistently high. Gates (1921) obtained positive correlations of +0.90, +0.96, +0.93 and +0.88 for grades three through six, respectively. On an early test of reading, Paterson and Tinker (1930) found a corrected correlation coefficient of +1.00. Tinker (1932) concluded:

> The only adequate method of discovering the true relation between speed and comprehension in specific reading skills is to measure rate and comprehension on the same or strictly comparable material (p. 160).

He further stated that there is a close "relation" between speed and comprehension in reading. In a later study, Tinker (1939) reported that the relationship between speed and comprehension decreased as difficulty increased, especially when tests required specialized information. He concluded that when textual content is within the reader's experiential background, speed and comprehension are highly correlated.

Gray (1925) summarized several investigations and concluded that the evidence indicated a positive correlation between speed and comprehension, that the correlation is variable, and that correlations are higher with children than with adults. Tinker reviewed the research on the subject in 1958 and reported that the "trend of results" found that correlations between speed and comprehension

proceed from no correlation to a highly significant correlation.

Eurich (1930) found a stronger relationship between a pre-reading test of information and reading rate than he did between reading speed and a post-reading test of comprehension. This finding indicated that familiarity with the material affected correlations. The 26 correlations he reported had an average value of +0.31, indicating a low-to-moderate correlation between speed and comprehension. Thurstone (1944) reported correlations of +0.11 on physical science material, +0.42 on literary material and +0.44 on social science material. The degree of relationship between rate and comprehension appears to depend upon the method of testing, the subject, difficulty of materials and the reader's familiarity with the test material.

Many variables which may have had an influence upon the correlation between rate and comprehension have been considered. Reading rate has long been used as a measure because many observations can be drawn from rate testing. It was important for investigators to try to determine what items influenced rate.

Variables Determining Reading Rate. In an early study, Quantz (1897) defined the following variables in reading rate: visual perception, practice in reading, power of concentration, mental alertness, complex reaction times and scholarly ability. O'Brien (1921) reviewed the literature on speed in silent reading and concluded that the following variables affect rate: practice in rapid silent reading, amount of vocalization, training in perception, subject matter difficulty, habits of eye movement, purpose for reading, concentration of attention, ability to grasp meaning, reaction time, visual imagery, recognition of the value of rapid silent reading, and desire to read rapidly. He advocated rate training to increase perceptual span.

Indications that visual and auditory processing time as well as memory may be variables in reading rate and comprehension have been found by several researchers. Geyer (1968) said:

> Until recent years neurologists believed the visual system to be relatively simple . . . the reading process was conceived as a series of tachistoscopic presentations flashed to the brain by saccadic movements of the eye (p. 45).

Hebb (1961) cited older references which stated that the reading process was seen as depending on the instantaneous recognition of larger and larger blocks of letters.

In a study by Katz and Wicklund (1971), good and poor readers were measured on word scanning tasks. They found that there was no significant difference in scanning rate. Results pointed to the conclusion that the process involved in simple reaction time did not account for good reading in scanning tasks:

> Since good and poor readers did not differ in scanning rate either, the superiority of good readers may be due to a greater facility in retrieving the key word just prior to scanning. That is, differences between good and poor readers may be found in memory processes; our data have not suggested differences due to perceptual or motor processes (p. 270).

Rogers' (1969) research suggested that poor auditory memory is a causal variable in reading retardation as measured in oral reading and that auditory memory can be influenced by reinforcement techniques. In contrast to the Katz and Wicklund (1971) findings, Traxler (1934) believed that some individuals have slow rates because of a lag in thought processing. The reported correlation between rate and association speed was relatively low when the effects of vocabulary and intelligence were considered, yet Traxler believed the evidence sufficient to conclude that some readers have slow rates because they process information inefficiently. Sutherland (1946) concluded that rate of reading and rate of perception are related to perceptual span.

The Holmes-Singer Substrata-factor Theory (Singer, 1965) of reading was designed to explain the mental structure and dynamics involved in reading ability. Singer (1965) asserted:

> . . . general reading ability is an audiovisual processing skill of symbolic reasoning. This ability divides into two major interrelated components: speed and power of reading (p. 1).

Joined by short and long term memory processes, neurological subsystems may be mobilized to attain speed and power. These subsystems are identified as input (sensation and perception of stimuli), mediation (interpreting, inferring, and integrating ideas) and output (response formulation).

The speed of reading criterion to identify variance accounted for was assessed for the total sample as follows: auding, 14 percent; visual verbal meaning, 18 percent; homonyms, 9 percent; reasoning, 8 percent; literary interest, 3 percent; unaccounted for, 45 percent. Holmes and Singer (1966) offered thought-provoking ideas on the reading process and the relationship of speed and comprehension to their subabilities described:

> Reading is much more complex than is usually supposed. In the first place it is a combination of speed and comprehension, and the subabilities needed vary according to which component is being stressed. In the second place, two individuals may read the same material with equal speed and comprehension by mobilizing quite different sets of neurophysiological, psycholinguistic, and audiovisual perceptual skills into a "working-system" marshaled to cope efficiently with the intellectual demands of the reading task. Finally, the composition of the working-system must change or shift as the child becomes an adolescent and later an adult.
>
> It is now evident that minimum amounts of certain basic skills, such as command of vocabulary, range of information, and the ability to listen with comprehension are absolutely necessary for any degree of success in reading, regardless of the method by which the child is taught. But beyond these basic abilities a student may draw upon such unlikely factors as mechanical aptitude or elements of musical ability in order to compete successfully with his peers in reading.
>
> In addition, some interesting facts emerge from the comparative analyses of various groups. Even when there are no differences in the reading achievement or intelligence of the two groups, boys draw upon a different set of abilities than girls (p. 22).

The intelligence of the reader also seems to affect the correlation between speed of reading and comprehension. Carlson's (1949) research examined whether speed of reading is a unitary skill that can be acquired by some sort of pacing device, for example, or a complicated (and idiosyncratic) process acquired by each individual. He concluded that there is a tendency for less intelligent readers to read better at faster rates. He found that intelligence, readers' purposes, difficulty of material, continuity of text and opportunity to reexamine the text while answering questions also affected comprehension. There was an

increasingly negative degree of relationship between rate and comprehension as material difficulty increased when middle and low intelligence groups were tested.

Physical Constraints. Reading rate may not only be limited by processing time or memory but by the related physical constraints of the eye and its movement/fixation capabilities as well. Spache (1962) observed that if a reader reads

> . . . most of the words on a page, it is impossible to read faster than 800 to 900 words per minute. This fact derives from the amount of time necessary for 1) the shortest fixation (approximately 1/6 to 1/5 of a second during which reading occurs, 2) for the sweep or saccade to the next fixation (1/30 to 1/25 of a second), and 3) the maximum number of words that the eye can possibly see with a single fixation during the continuous reading (probably 2.5 to 3 words) (p. 262).

Taylor (1962) reported research of eye-movement studies and reported that through hundreds of studies involving eye-movement photography, it has been determined that no one has an average span that permits the intake of more than one word at a fixation. He quoted research which documented that the average span for the college student reading 230 words per minute is only 1.1 words. Pauk (1968) stated that there was no evidence that the mind can even deal with more than one word at a time.

Shores (1968) noted that the physical presentation of printed material may determine how rapidly one reads and how well one comprehends. He stated that these two variables may be affected by

> . . . size of type, type style, blackness and sharpness of print, quality and tone of paper, size of page, organization on the page, amount of white space, kinds of illustrations, placement of illustrations on the page, relations of illustrations to text, heading and subheading, and overall organization and design (p. 23).

Much research has been directed toward the role of subvocalization or implicit speech in reading rate and comprehension. Betts (1950) believed that:

> . . . any observable form of vocalization--such as silent lip movement. . . retards the rate of silent reading which has been common professional knowledge since early scientific studies of reading (p. 450).

In contrast to Betts' opinion, several authors contend that vocalization--overt or implicit--appears to be an integral part of the reading process. Rose (1969) reasoned that acoustic rehearsal of stimuli is important in

meaningful reading. Sperling (1963) asserted that utilization of items in reading is not limited by visual factors but by the rehearsal process to a rate of ten syllables per second or slower.

Both Smith (1971) and Huey (1968) felt that optimal reading rate is directly related to comprehension. Rankin's (1963) research suggested that comprehension may be dependent upon speed of reading among mentally competent readers. Smith (1975) presented a cogent discussion of the effect of rate on comprehension:

> The combined limitations of short-term memory and long-term memory and of tunnel vision can be critical in reading. For example, it is probably impossible to read with comprehension at slower than 200 words a minute--the units we are trying to get into short-term memory and long-term memory will be too small to be of any use. Similarly, it is impossible to read for meaning if we stop to read every individual word; short-term memory will soon overflow with a meaningless clutter of disconnected words and bits of words, and it would be most impractical to try to cram such "information" into long-term memory. To read with comprehension we must use visual information parsimoniously and memorize economically; we cannot read sentences as if they were sequences of unrelated words. In fluent reading, individual words come last rather than first (p. 70).

Several studies were reported which correlated rate and comprehension. The subjects for these studies were from various age and reading level groups. Conflicting results in many cases depended upon the ages of the subjects, how they were tested, the materials used in testing and the statistical treatment of collected data. Some of the findings were reported as corrected correlation coefficients while others were not.

Results

Pearson product moment correlations for rate and comprehension on paced and non-paced material were computed. Two hundred two paired scores were obtained on both paced and non-paced reading selections. Results showed a strong relationship ($+.32$, $p > .001$) between rate and comprehension on non-paced reading. Mean rate was 255 words per minute, and the mean comprehension score was 60.75 percent. A correlation of $+.08$ was found between rate and comprehension on paced material and was not significant. Mean rate was 365 words per minute with a mean comprehension score of 40.67 percent. Mean difference in paced and

non-paced comprehension scores on a t test for correlated data was found to be significant at the .001 level as was mean difference in paced and non-paced rate scores.

A scattergram of rate and comprehension frequencies by deciles provided information which was used graphically to illustrate the relationship between rate and comprehension for both paced and non-paced scores. Reading speed scores were divided into deciles, each category containing approximately 10 percent of the population (N = 202). The exact limits and midpoints of each interval were calculated for the decile categories. Figure 1 illustrates the increasingly positive relationship between rate and comprehension which occurs up to the 225-250 words per minute range. After that range the relationship exhibits a change and a variation in rate does not seem to markedly affect comprehension.

Figure 2 illustrates the relationship between rate and comprehension on paced material. There seemed to be little change in the relationship between rate and comprehension on paced material, and the representation was almost linear.

Conclusions and Implications

According to the results of this research, the relationship between reading rate and comprehension is not constant in non-paced material. Below approximately 250 words per minute there was positive and significant correlation between rate and comprehension, yet above that rate little or no relationship existed. At above 250 words per minute on non-paced material and on all paced material, a difference in comprehension must be accounted for by variables other than reading rate. It may be that interest or experience factors become determinants of comprehension, or that the pacing device itself may affect comprehension.

Also of interest is the question as to whether the pacing device contributed to higher rate scores on non-paced material, because students completed both types during each class meeting. Although the mean rate for non-paced was lower than that of paced material, the mean rate may indeed have been lower still had

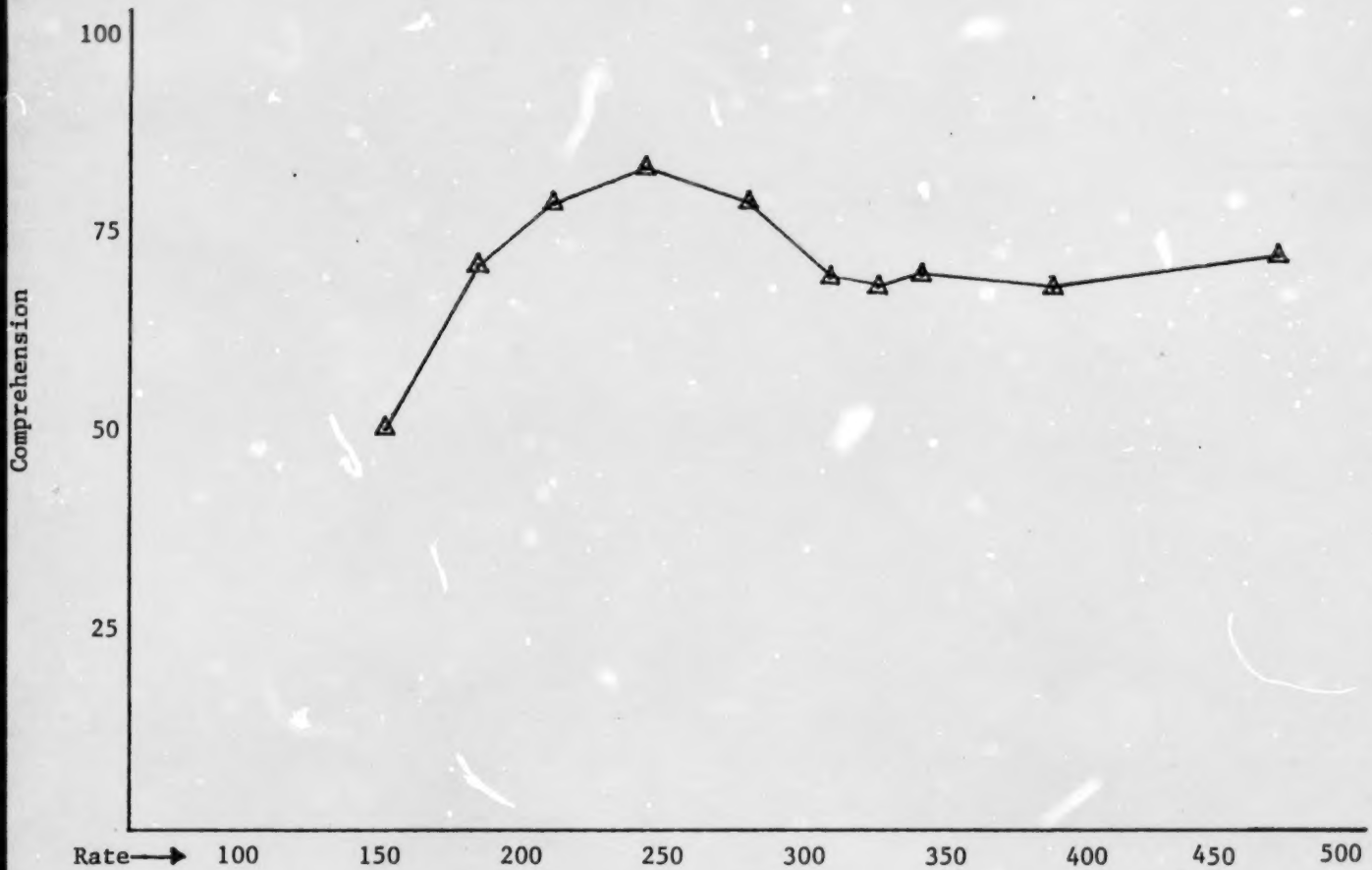

Figure 1

Graph Representing Relationship of Rate to Comprehension Scores on Non-Paced Materials

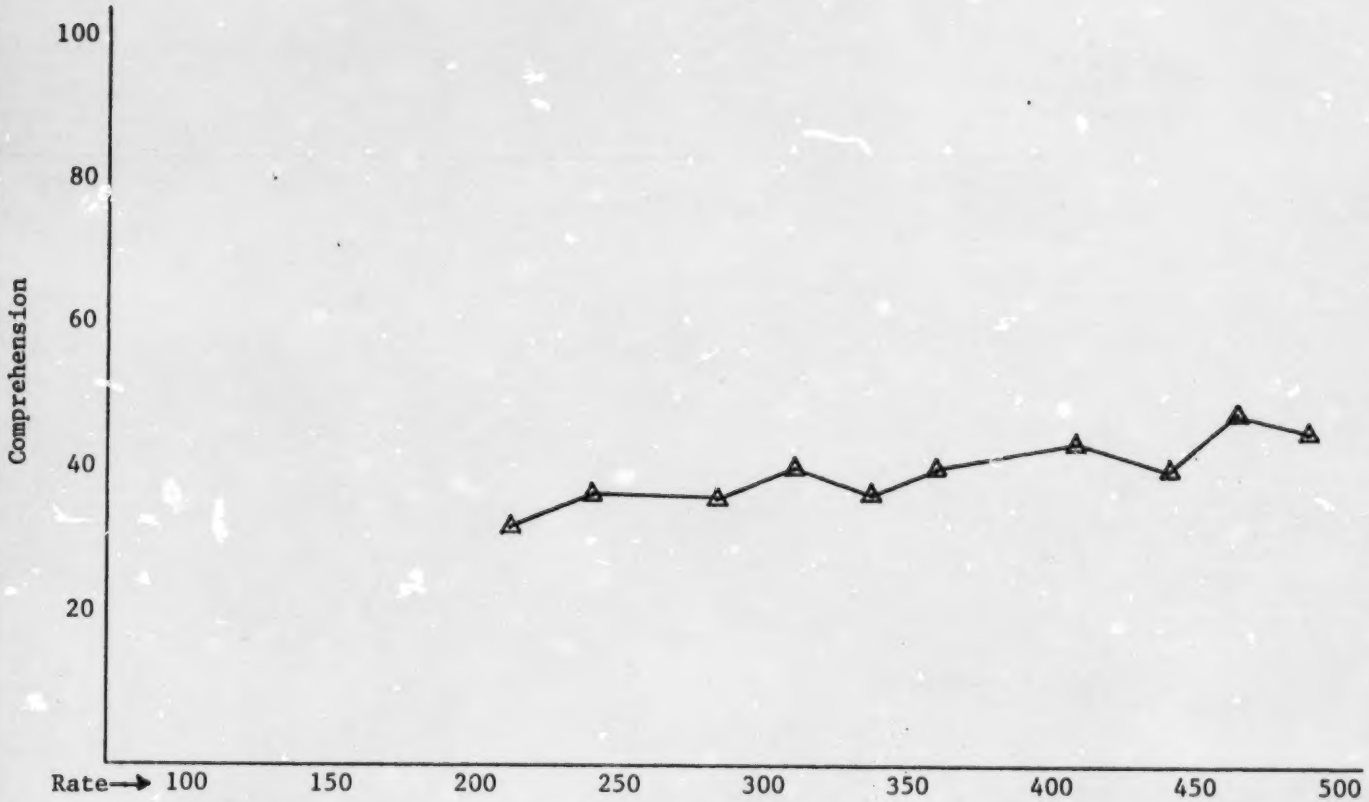

Figure 2

Graph Representing Relationship of Rate to Comprehension Scores on Paced Materials

there been no paced practice. Further study is planned to investigate this question.

The investigators believe that the relationship between rate and comprehension depends upon the rate and comprehension ranges examined. In beginning reading, there is a change in the relationship at approximately 55 words per minute (Strader, 1975). It seems that the critical rate changes as the age and reading proficiency of subjects is varied.

This study leads only indirectly to instructional applications. As a result of this study more investigation into use of reading pacers will be instigated. Motivational aspects versus concrete data on pacer use may be questioned. The time constraint for reading definitely affected the relationship between rate and comprehension. However, confounding of the variables may have occurred in carry-over to non-paced material. Further investigation is necessary.

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